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TM 3-215
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**TECHNICAL MANUAL
MILITARY CHEMISTRY AND CHEMICAL AGENTS**

CHANGES } WAR DEPARTMENT,
No. 1. } WASHINGTON 25, D. C., 14 October 1943.

TM 3-215, 21 April 1942, is changed as follows:

Symbols for certain war gases as referred to in this manual are changed as follows. These symbols will be corrected wherever they occur in the manual.

War gas	Old	Symbol	New
Mustard gas.....	HS		H
Lewisite.....	M-1		L

[A. G. 300.7 (2 Oct 43.)] (C 1, 14 Oct 43.)

BY ORDER OF THE SECRETARY OF WAR:
G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
J. A. ULIO,
*Major General,
The Adjutant General.*

RG 297
351/47/15+22/6+2
TM 3-215
Box 9
Fld. TM 3-215 April 21, 1942

TECHNICAL MANUAL
MILITARY CHEMISTRY AND CHEMICAL AGENTS

CHANGES } WAR DEPARTMENT,
No. 2 } WASHINGTON 25, D. C., 23 February 1945.

TM 3-215, 21 April 1942, is changed as follows:

Terminology for certain war gases as referred to in this manual is changed as follows. These terms will be corrected throughout the manual wherever they occur.

New terminology

Chemical agents—war gases:

Old terminology

Casualty gases:

Blister gases—

Vesicants.

Choking gases—

Lung irritants.

Blood and nerve poisons—

Systemic poisons.

Harassing gases:

Vomiting gases—

Irritant smokes or ster-
nutators.

Tear gases—

Lacrimators.

Lethal concentrations contained in this change were determined by experiments on mice. No factor is known which converts these concentrations into lethal concentrations for men.

136. **General.**—*a.* Chemical agents may * * * action determines classification.

(1) *Physiological effect.*

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(b) (As changed by C 1.) **Blister gases.**—H, L, ED, **PD.**

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(c) **Blood and nerve poisons.**—Carbon monoxide, hydrocyanic acid, arsine, cyanogen chloride.

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(2) *Tactical employment.*

(a) *Casualty.*—Blister gases, blood and nerve poisons, and choking gases.

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(4) *Physical condition* (at 20° C. [68° F.] and 760 mm. pressure).

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(b) (As changed by C 1.) *Liquids.*—PS, H, L, ED, CNS, CNB, FM, FS, **PD.**

(c) *Gases.*—C 1, CG, SA, CK, AC.

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TABLE I.—Summary of war gases

a. Choking gases.

	Properties	Chlorine	Phosgeno	Chlorpicrin
16	Lethal concentration.....	10-minute exposure to 1.96 oz./1,000 cu. ft. air (mice).	10-minute exposure to 0.18 oz./1,000 cu. ft. air (mice).	10-minute exposure to 1.5 oz./1,000 cu. ft. air (mice).

b. Blister gases.

	Properties	Mustard gas	Lewisite	Ethyl-di-chlorarsine	Phenyldichlorarsine
1	Common name.....	*****	*****	*****	Phenyldichlorarsine.
2	Chemical name.....	*****	*****	*****	Phenyldichlorarsine (C ₆ H ₅ AsCl ₂).
3	CW symbol.....	*****	*****	*****	PD.
4	Melting point.....	*****	*****	*****	-22.5° C. (-8.5° F.).
5	Boiling point.....	*****	*****	*****	254.4-257.6° C. (489.9-495.7° F.).
6	Volatility at 20° C. (68° F.).....	*****	*****	*****	0.26 oz./1,000 cu. ft. air.
7	Vapor pressure at 20° C. (68° F.).....	*****	*****	*****	0.022 mm of Hg.
8	Vapor density compared to air.....	*****	*****	*****	7.7.
9	Density of liquid at 20° C. (68° F.).....	*****	*****	*****	1.65 gm/ml.
10	Solvents for.....	*****	*****	*****	Alcohol, benzene, chloroform.
11	Action on metals.....	*****	*****	*****	None.
12	Action with water.....	*****	*****	*****	Hydrolyzes readily to HCl and phenylar-senious oxide (C ₆ H ₅ AsO).
13	Odor in air.....	*****	*****	*****	Irritating.
14	Odor detectable at.....	*****	*****	*****	Less than 10 mg./cu. m.
15	Minimum irritating concentration.....	*****	*****	*****	Less than 10 mg./cu. m.

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16	Lethal concentration.....	10-minute exposure to 0.147 oz./1,000 cu. ft. air (mice).	*****	10-minute exposure to 0.34 oz./1,000 cu. ft. air (mice).	10-minute exposure to 0.26 oz./1,000 cu. ft. air (when breathed) (mice).
17	Tactical classification.....	*****	*****	*****	Casualty gas.
18	Persistency.....	*****	*****	*****	Persistent.
	Summer.....	*****	*****	*****	1 day to 1 week.
	Winter.....	*****	*****	*****	Several weeks.
19	Physiological effect.....	*****	*****	*****	Causes burns in skin and lung tissues and arsenical poisoning in body; injures eyes; causes sneezing.
20	Time after exposure for casualty to develop.....	*****	*****	*****	6 to 10 hours.
21	First aid.....	*****	*****	*****	Use BAL ointment in eyes; blot liquid from skin; use protective ointment. If breathed, treat as choking gas. Evacuate to hospital.
22	Field method of destroying.....	*****	*****	*****	Chloride of lime; water; sodium hydroxide; oxidizing agents.
23	Protection required.....	*****	*****	*****	Gas mask and protective clothing.
24	Stability in storage.....	*****	*****	*****	Stable in steel containers.
25	Suitable munitions.....	*****	*****	*****	Airplane spray and bombs, artillery and chemical mortar shell, land mines.
26	Marking on munitions.....	*****	*****	*****	2 green bands, PD gas (probably).

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c. Tear gases.

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d. Vomiting gases.

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e. Blood and nerve poisons (Added).

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	Properties	Hydrocyanic acid	Cyanogen chloride	Arsine
1	Common name	Hydrocyanic acid	Cyanogen chloride	Arsine.
2	Chemical name	Hydrocyanic acid (HCN)	Cyanogen chloride (CNCl)	Arsenic trihydride (AsH ₃).
3	CW symbol	AC	CK	SA.
4	Melting point	-14° C. (6.8° F.)	-6.5° C. (20° F.)	-116.3° C. (-177.3° F.).
5	Boiling point	25.6° C. (78° F.)	13° C. (55° F.)	-62.4° C. (-80.3° F.).
6	Volatility at 20° C. (68° F.)	898 oz./1,000 cu. ft. air	3,400 oz./1,000 cu. ft. air	45,000 oz./1,000 cu. ft. air.
7	Vapor pressure 20° C. (68° F.)	607 mm. Hg.	1,010 mm. Hg.	11,000 mm. Hg.
8	Vapor density compared to air	0.93	2.1	2.7.
9	Density of liquid	0.715 gm/ml [at 0° C. (32° F.)].	1.204 gm/ml [at 0° C. (32° F.)].	1.34 gm/ml [at 20° C. (68° F.)].
10	Solvents for	Water, alcohol, ether	Ether	Turpentine.
11	Action on metals	Negligible on steel in presence of 0.05% H ₃ PO ₄ .	Attacks iron, steel, and silver very slowly. No action on lead.	Reacts slowly with copper, brass, and nickel.
12	Action with water	Gradually decomposes	Hydrolyzes slowly	Somewhat soluble (1 part arsine to 5 parts water).
13	Odor in air	Bitter almonds	Irritating	Slight garlic.
14	Odor detectable at	Undependable	Detected by irritation before odor can be detected.	0.11 mg/P.
15	Minimum irritating concentration.		0.0025 oz./1,000 cu. ft. air	Undetermined.
16	Lethal concentration	10-minute exposure to 0.227 oz./1,000 cu. ft. (mines).	10-minute exposure to 0.75 oz./1,000 cu. ft. air (mines).	10-minute exposure to 0.23 oz./1,000 cu. ft. air (mines).
17	Tactical classification	Casualty gas	Casualty gas	Casualty gas.
18	Persistence	1 to 10 minutes nonpersistent.	1 to 10 minutes nonpersistent.	Nonpersistent.
	Summer			1 to 5 minutes.
	Winter			1 to 10 minutes.

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19	Physiological effect	Paralysant, quickly lethal in high concentrations only.	Paralysant, irritates eyes and respiratory tract. Quickly lethal in high concentrations; delayed lethal action at lower concentrations.	Difficulty in breathing, headache, fainting, nausea, followed by anemia and jaundice.
20	Time after exposure for casualty to develop.	At once	At once	2 hours to several days.
21	First aid	Adjust mask, remove to pure air, artificial respiration if necessary. Inhale amyl nitrite fumes.	Adjust mask, remove to pure air, artificial respiration if necessary. Inhale amyl nitrite fumes.	Keep quiet, evacuate to hospital.
22	Field method for destroying	Aeration	Aeration	Aeration.
23	Protection required	Gas mask	Gas mask	Gas mask.
24	Stability in storage	Stable in steel in presence of 0.05% H ₃ PO ₄ .	Stable in steel	Stable in steel containers.
25	Suitable munitions			Bombs, artillery and mortar shell, grenades.
26	Marking on munitions	1 green band AC gas	1 green band CK gas	1 green band—SA gas (probably).

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138. Chlorine (Cl).

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d. Detailed properties.

Lethal concentration----- 10-minute exposure to 1.96 oz./1,000 cu. ft. air (mice).

139. Phosgene (CG).

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d. Detailed properties.

Lethal concentration----- 10-minute exposure to 0.18 oz./1,000 cu. ft. air (mice).

140. Chlorpicrin (PS).

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d. Detailed properties.

Lethal concentration----- 10-minute exposure to 1.5 oz./1,000 cu. ft. air (mice).

142. Mustard gas (H).

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d. Detailed properties.

Lethal concentration----- 10-minute exposure to 0.147 oz./1,000 cu. ft. air (mice).

143.1. Mustard gas—Lewisite mixture (HL) (Added).—Mustard gas may be mixed with lewisite for cold-weather operations. Mustard gas alone freezes at about 46° F., while a mix of equal parts H and L by weight has a freezing point of about 0° F., and of equal parts by volume, about minus 25° F.

144. Ethyldichlorarsine (ED).—*a. Detailed properties.*

Lethal concentration----- 10-minute exposure to 0.34 oz./1,000 cu. ft. air (mice).

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144.1. Phenylidichlorarsine (PD) (Added).—*a. Detailed properties.*

erties.

Chemical name----- Phenylidichlorarsine.

C W symbol----- PD.

Persistence: Summer----- 1 day to 1 week.

Winter----- Several weeks.

Tactical classification----- Casualty gas.

Physiological classification----- Blister gas.

Odor in air----- Irritating.

Melting point----- -22.5° C. (-8.5° F.).

Boiling point----- 254.4-257.6° C. (489.9-495.7° F.).

Volatility at 20° C. (68° F.)----- 0.26 oz./1,000 cu. ft. air.

Vapor pressure at 20° C. (68° F.)----- 0.022 mm. of Hg.

Vapor density compared to air----- 7.7.

Density of liquid at 20° C. (68° F.)----- 1.65 gm./ml.

Solvents for----- Alcohol, benzene, chloroform.

Action on metals----- None.

Stability on storage----- Stable.

Action with water----- Hydrolyzes readily.

Hydrolysis product----- Phenyl arsenious oxide and HCl.

Physiological action----- Burns skin and lung tissue; causes arsenic poisoning in body; injures eyes.

First aid----- Use BAL ointment in eyes; blot liquid from skin; use protective ointment. If breathed, treat as choking gas. Evacuate to hospital.

Odor detectable at----- Less than 10 mg./cu. m.

Minimum irritating concentration----- Less than 10 mg./cu. m.

Lethal concentration----- 10-minute exposure to 0.26 oz./1,000 cu. ft. air (when breathed) (mice).

Method of neutralizing----- Chloride of lime; water; sodium hydroxide; oxidizing agents.

Munitions suitable for use----- Airplane spray and bombs; artillery and chemical mortar shell; land mines.

Marking on munitions----- 2 green bands, PD gas (probably).

Protection required----- Gas mask and protective clothing.

b. Historical sketch.—The first toxic lung injurant war gas to appear in World War I was phenylidichlorarsine. This gas was first used by the Germans in September 1917 with, and as a solvent for, diphenylcyanarsine in Blue Cross No. 1 artillery shell, and later by the French, in a mixture with 40 percent diphenylchlorarsine, known as "Sternite."

158. Other possible agents.

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b. Rescinded.

* * * * * 158.1. Arsine (SA) (Added).—a. Detailed properties.

Chemical name.....	Arsenic trihydride (AsH ₃).
CW symbol.....	SA.
Persistence:	
Summer.....	1 to 5 minutes.
Winter.....	1 to 10 minutes.
Tactical classification.....	Casualty gas.
Physiological classification.....	Blood and nerve poison.
Odor in air.....	Slight garlic.
Boiling point.....	-116.3° C. (-117.3° F.).
Volatility at 20° C. (68° F.).....	-62.4° C. (-80.3° F.).
Vapor pressure at 20° C. (68° F.).....	45,000 oz./1,000 cu. ft. air.
Vapor density compared to air.....	11,000 mm. Hg.
Density of liquid at 50° C. (68° F.).....	2.7.
Solvents for.....	1.34 gm./ml. Turpentine.
Action on metals.....	Reacts slowly with copper, brass, and nickel.
Stability on storage.....	Stable in steel containers.
Action with water.....	Somewhat soluble (1 part arsine to 5 parts water).
Hydrolysis product.....	Does not hydrolyze.
Physiological action.....	Blood and nerve poison. Disintegrates red blood corpuscles. Causes difficulty in breathing, headache, fainting, nausea, followed by anemia and jaundice.
First aid.....	Keep quiet, evacuate to hospital.
Odor detectable at.....	0.11 oz./1,000 cu. ft. air.
Minimum irritating concentration.....	Undetermined.
Lethal concentration.....	10-minute exposure to 0.23 oz./1,000 cu. ft. air (mice).
Method of neutralizing.....	Aeration.
Munitions suitable for use.....	Bombs, artillery and mortar shell, grenades.
Marking on munitions.....	1 green band, SA gas (probably).
Protection required.....	Gas mask.

b. *Historical sketch.* Arsine was discovered by Scheele in 1775. It was not used as a war gas in World War I because of certain of its physical properties.

158.2. Hydrocyanic Acid (AC) (Added).—a. Detailed Properties.

Chemical name.....	Hydrocyanic acid.
CW symbol.....	AC.
Persistence.....	1 to 10 minutes (nonpersistent).
Tactical classification.....	Casualty gas.
Physiological classification.....	Blood and nerve poison.
Odor in air.....	Bitter almonds.
Melting point.....	-14° C. (6.8° F.).
Boiling point.....	25.6° C. (78° F.).
Volatility at 20° C. (68° F.).....	898 oz./1,000 cu. ft. air.
Vapor pressure at 20° C. (68° F.).....	607 mm. Hg.
Vapor density compared to air.....	0.93
Density of liquid at 0° C. (32° F.).....	0.715 gm./ml.
Solvents for.....	Water, alcohol, ether.
Action on metals.....	Negligible on steel in presence of 0.05% H ₂ PO ₄ .
Stability on storage.....	Stable in steel in presence of 0.05% H ₂ PO ₄ .
Action with water.....	Gradually decomposes.
Hydrolysis product.....	NH ₃ , HCOOH, and amorphous brown solids.
Physiological action.....	Paralyzant, quickly lethal in high concentrations only.
First aid.....	Adjust mask; remove to pure air; give artificial respiration if necessary. Inhale amyl nitrite fumes.
Odor detectable at.....	Undependable.
Minimum irritating concentration.....	10-minute exposure to 0.227 oz./1,000 cu. ft. air (mice).
Lethal concentration.....	
Method of neutralizing.....	Aeration.
Marking on munitions.....	1 green band, AC gas.
Protection required.....	Gas mask.

b. *Historical sketch.*—Hydrocyanic acid was first synthesized by Scheele in 1782. It was first used as a war gas during World War I by the French, who mixed it with arsenic trichloride and other compounds. The mixture, which was called Vincennite, was not stable and proved to be ineffective.

158.3. Cyanogen chloride (CK) (Added).—a. Detailed properties.

Chemical name.....	Cyanogen chloride.
CW symbol.....	CK.
Persistence.....	1 to 10 minutes (nonpersistent).
Tactical classification.....	Casualty gas.
Physiological classification.....	Blood and nerve poison.

BY ORDER OF THE SECRETARY OF WAR:

OFFICIAL:

J. A. ULIO

G. C. MARSHALL
Chief of Staff*Major General**The Adjutant General*

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For explanation of symbols, see FNI 21-6.

Odor in air.....	Irritating.
Melting point.....	-6.5° C. (20° F.).
Boiling point.....	13° C. (55° F.).
Volatility at 20° C. (68° F.).....	3,400 oz./1,000 cu. ft. air.
Vapor pressure at 20° C. (68° F.).....	1,010 mm. Hg.
Vapor density compared to air.....	2.1.
Density of liquid at 0° C. (32° F.).....	1.204 gm./ml.
Solvents for.....	Ether.
Action on metals.....	Attacks iron, steel, and silver very slowly. No action on lead.
Stability on storage.....	Stable in steel.
Action with water.....	Hydrolyzes slowly.
Hydrolysis product.....	NH ₄ Cl and CO ₂ .
Physiological action.....	Paralysant, irritates eyes and respiratory tract. Quickly lethal in high concentrations; delayed lethal action at lower concentrations.
First aid.....	Adjust mask, remove to pure air. Artificial respiration if necessary. Inhale amyl nitrite fumes.
Odor detectable at.....	Detected by irritation before odor can be detected.
Minimum irritating concentration.....	0.0025 oz./1,000 cu. ft. air.
Lethal concentration.....	10-minute exposure to 0.75 oz./1,000 cu. ft. air (mice).
Method of neutralizing.....	Aeration.
Marking on munitions.....	1 green band CK gas.
Protection required.....	Gas mask.

b. Historical sketch. Cyanogen chloride was first synthesized by Berthollet in 1802. It was first used as a war gas by the French in 1916.

[AG 300.7 (5 Jan 45)]